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UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0649008 A2	(NGK INSULATORS) See Figs.1&4, page 4 lines 33-40, page 7 lines 19-49	1,9,16,20, 28,35,39, 47

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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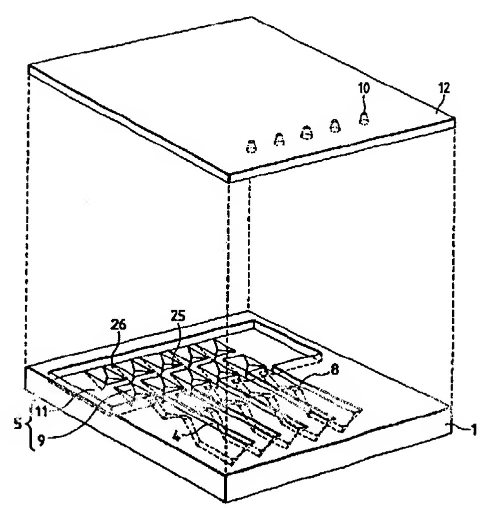
(54) Ink jet recording head, its fabricating method and ink jet recording apparatus

(57) An object of the present invention is to provide an ink jet recording head which can compensate for shortage of mechanical strength of an ink reservoir (5) by preventing the piezoelectric film (3) on an ink reservoir from cracking or being broken due to the vibration of a piezoelectric film (3) or flowing or mechanical vibration of ink. The ink reservoir (5) has at least two plane orientations at its bottom and is given different depths.

FIG. 1



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To solve this object the present invention provides an ink recording head as specified in claim 1, a method as defined in claim 8, and an ink recording apparatus as specified in claim 13.

To summarize, the present invention solves the above problem by providing a small-size ink jet recording head which can enhance the mechanical strength of the ink reservoir so that the lower electrode, piezoelectric film and upper electrode do not crack and also provide for an adequate supply of ink.

In order to solve the above problem, an ink jet recording head according to the present invention comprises especially: a nozzle plate having a plurality of nozzle openings for discharging ink; a flow-path forming plate including a plurality of pressure generating chambers communicating with said nozzle openings, respectively, ink supply paths for supplying ink to said pressure generating chamber and a reservoir communicating with said ink supply paths; a vibrating plate formed on said flow-path forming plate; and a thin-film piezoelectric element having electrodes formed at the areas on said vibrating plate corresponding to said pressure generating chambers and a piezoelectric element, wherein said reservoir includes a common ink chamber and a plurality of grooves.

Of course, the enclosed claims are only a non-limiting approach for defining the present invention.

The above objective and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the accompanying drawings in which:

Fig. 1 is an exploded perspective view of the ink jet recording head according to the present invention.
Fig. 2(a) is a plan view of the ink jet recording head according to the present invention; and Fig. 2(b) is a sectional view taken along line I - I'.
Fig. 3(a) to Fig. 3(d) are sectional views showing the process of fabricating the ink jet recording head according to the present invention.
Fig. 4(a) to Fig. 4(c) are sectional views showing the process of fabricating the ink jet recording head according to the present invention.
Fig. 5(a) to Fig. 5(c) are sectional views showing the process of fabricating the ink jet recording head according to the present invention.
Fig. 6(a) to Fig. 6(c) are sectional views showing the process of fabricating the ink jet recording head according to the present invention.
Fig. 7(a) and Fig. 7(b) are plan views for a glass mask which is used in a method for fabricating the ink jet recording head according to the present invention.
Fig. 8 is a perspective view showing an example of how the ink jet recording head may be applied.
Fig. 9(a) is a perspective view of a conventional ink jet recording head and Fig. 9(b) is a sectional view taken along line II - II' in Fig. 9(a).

Now referring to the drawings, an explanation will be given of the embodiments of the present invention.

Fig. 1 is an exploded perspective view of the ink jet recording head according to the present invention. Fig. 2(a) is a plan view of a flow path forming substrate described below. Fig. 2(b) is a sectional view taken on line I - I' of Fig. 2(a).

In these figures, reference numeral 1 denotes a flow path forming substrate, or spacer, fabricated by etching a single-crystal Si substrate having a plane orientation of (110) including a plurality of pressure generating chasers 4; a reservoir 5 for supplying ink into these pressure generating chambers; and ink supply paths 8 for communicating these pressure generating chambers 4 with the reservoir 5 with constant fluid resistance. On the one side of the spacer 1, a nozzle plate 12 is secured in which a nozzle opening 10 is made to communicate with one end of the pressure generating chambers 4. On the other side of the flow path forming substrate 1, a vibrating plate 2 is formed. At the positions corresponding to the pressure generating chambers 4 on the vibrating plate 2, a lower electrode 6, a piezoelectric film 3 and upper electrode 7 are formed.

The reservoir 5 includes a common ink chamber 11 which is a single groove having a thickness equal to that of the ink supply paths 8 over the entire area of the reservoir 5, and a plurality of grooves 9 communicating with the common ink chamber 11, respectively. Each groove 9 has wall faces 21, 22. The wall face 21 is a (111) plane appearing at an angle of about 35° when the single-crystal Si with the plane orientation of (110) is anisotropically etched. The wall face 22 is a (111) plane having an angle of 90° from the plane orientation (110).

The respective grooves 9 are arranged so that they are partitioned by walls 25, 26 in a lattice form. The width of the plane 25a, which constitutes the bottom of the common ink chamber 11 of the wall 25 in a direction of the arrangement of the pressure generating chambers 4 at the center of the reservoir, is larger than that of the plane 26a of each of the walls 26 formed at the same pitch as that of the pressure generating chambers, which also constitutes the bottom of the common ink chamber 11, thus enhancing the strength of the reservoir.

Such a configuration of the reservoir can strengthen the mechanical strength of the reservoir and also provide a sufficient supply of ink without greatly increasing its size.

For example, with an ink jet amount of 20 μcc for each nozzle opening, when ink is jetted simultaneously from 10 nozzle openings at a rate of 14400 dots per 1 sec, the reservoir 5 is required to have a volume of 0.271 mm^3. Since the reservoir according to the present invention has grooves surrounded by the (111) planes formed by anisotropic etching and appearing at the angle of about 35° from the (110) plane, the volume of the reservoir 5 can be increased to 1.2 mm^3, thus assuring a sufficient amount of ink.

Although the arrangement pitch of the grooves 9 of the reservoir 5 is not limited particularly, it is preferable to arrange the grooves 9 at the pitch equal to that of the pressure generating chambers 4 so that the paths of supplied ink having the same shape can be provided for the pressure generating chambers. Thus, ink can be supplied to the pressure generating chambers 4 with no variation in the resistance of the flow path of ink so that the amount of ink supplied to the pressure generating chambers can be made uniform.

In this embodiment, although two columns of the grooves 9 of reservoir 5 were formed in a direction of arranging the pressure generating chambers 4, one or three or more columns of grooves 9 can be formed.

Each of the pressure generating chambers is formed by wall faces 24, 23. The wall face 24 is a (111) plane appearing at an angle of about 35° when the single-crystal Si with the plane orientation of (110) is anisotropically etched. The wall face 23 is a (111) plane having an angle of about 90° from the plane orientation of (110).

Incidentally, in Fig. 2, a groove 29 and a flow path 28 constitute a flow path for communicating the reservoir 5 with the ink supply paths 8. Since the width of the reservoir 5 is different from that of the ink supply paths 8, when the single-crystal Si substrate is etched, the shape of the connecting portion between the reservoir 5 and the ink supply paths 8 is apt to be unstable. But, by forming the flow path between the reservoir 5 and the ink supply paths 8, the ink supply paths 8 can be formed accurately. The groove 29 and flow path 28 may be omitted provided that the accuracy in fabrication can be assured.

An explanation will be given of the method of fabricating the ink jet recording head according to the present invention.

As shown in Fig. 3(a), a single-crystal Si substrate 201 with a crystal orientation of (110), for forming the flow path forming substrate 1, having a thickness of 220 μm is heated to 1100° C for 60 minutes in an oxygen atmosphere containing water vapor to form silicon oxide films 207 each having a thickness of 1 μm on both sides of the single-crystal Si substrate 201 through thermal oxidation. The silicon oxide film 207 serves as an insulating film of an active element formed thereon and also as an etching mask when the single-crystal Si substrate 201 is to be etched. The etching mask should not be limited to the silicon oxide film, but may be any film (single-crystal Si etch-resistant film) such as a silicon nitride film or metallic film as long as it has resistance to an Si etching liquid.

On the single-crystal Si substrate 102 with the silicon oxide film 207 formed, a zirconium film is formed by sputtering. The zirconium film is oxidized by thermal oxidation to provide a zirconium oxide having a thickness of about 0.8 μm, thereby forming a film 201 for forming the vibrating plate 2.

Further, a platinum (Pt) film having a thickness of 0.2 μm is formed on the film 201 to provide a film 202 for forming the lower electrode 6. Likewise, on the film 202, a piezoelectric film 203 of a zircon oxide titanic film (PZT) having a thickness of 1 μm is formed. On the piezoelectric film 203, an aluminum film having a thickness of 0.2 μm is formed to provide a film 204 for forming the upper electrode 7. In order to improve the contact strength between the adjacent films, an intermediate layer of titanium (Ti), titanium oxide (TiO) and chrome (Cr) may be laminated between the adjacent films.

As shown in Fig. 3(b), photoresist (not shown) is applied to the entire surface of the film 204, piezoelectric film 203 and film 202 by spin coating. The photoresist applied is patterned in a desired shape, now corresponding to the pressure generating chambers by photolithography and etching. In making such a pattern, patterning may be effected for each of the film 202, piezoelectric film 203 and film 204 and thereafter these films may be laminated.

Hereinafter, the surface on the side of the single-crystal Si substrate 102 where the piezoelectric film 203 is formed is referred to as the "active surface" and the face opposite thereto is referred to as the "non-active surface".

As shown in Fig. 3(c), positive-type photoresists 209 and 208, which are generally used, are applied to the entire active and non-active surfaces, respectively. In this case, application of the photoresist may be carried out by roll coating. The photoresist 209 on the active surface serves to protect a silicon oxide film from being etched. The substrate is subjected to pre-baking at a temperature of 80° for 10 minutes.

As shown in Fig. 3(d), the photoresist 208 is covered with a glass mask 210 having a desired pattern and irradiated with ultraviolet rays. In the glass mark 210, the areas where the ultraviolet rays permeate are indicated by a solid slender line and the areas from which they are reflected are indicated by a bold solid line. The plan view of the glass mask is shown in Fig. 7(a).

As shown in Fig. 4(a), the positive-type photoresists 209 and 208 are developed. The development is carried out in such a manner that the substrate is immersed in a usual alkaline development liquid while the liquid is stirred and swung for one minute and 30 seconds at room temperature. Thereafter, the substrate is subjected to post baking at 140°C for ten minutes.

As shown in Fig. 4(b), the silicon oxide film 207 is patterned by etching using buffering hydrofluoric acid. In this case, the silicon oxide film 207 having a thickness of about 1 μm can be patterned by etching for ten minutes.

As shown in Fig. 4(c), the patterned photoresist 208 is covered with a glass mask 211 having a pattern corresponding to the reservoir 5 and the ink supply pates 8, and irradiated with ultraviolet rays. The plan view of the glass mask is shown in Fig. 7(b).

As shown in Fig. 5(a), the positive-type photoresist is developed. As described above, the development is carried out in such a manner that the substrate is

immersed in a usual alkaline development liquid while the liquid is stirred and swung for one minute and 30 seconds at room temperature. Thereafter, the substrate is subjected to post baking at 140°C for ten minutes.

As shown in Fig. 5(b), the positive-type photoresists 209 and 208 are developed.

As shown in Fig. 5(b), the silicon oxide film 207 of the developed/removed areas of the positive-type photoresist is patterned by half-etching using buffering hydrofluoric acid. In this case, the thickness of about 1 μm of the silicon oxide film 207 is reduced to about 0.5 μm by etching for five minutes. The photoresist other than the patterned area is exposed to light and developed again. The technique of forming areas having different thicknesses is referred to as multiple light exposure. This step permits the silicon oxide film 207 to be removed in the step of Fig. 6(a).

After the photoresists 208 and 209 are removed using removal liquid or ashing, as shown in Fig. 5(c), the single-crystal Si substrate 102 is anisotropically etched using an alkaline liquid. Thus, grooves 104 and 101 constituting the pressure generating chamber 4 and reservoir 5, respectively are formed. This is because when the single-crystal Si substrate 102 having a plane orientation of (110) is etched using the alkaline liquid, a (111) plane appears at an angle of 35° from the plane of (110) to stop further etching.

Therefore, as shown in Fig. 5(c), the depth b of the groove to be etched at the deepest position defines the distance c between both edges of the groove to be etched. Thus, by changing the distance c between both edges, the thickness of the single-crystal Si substrate 102 can be freely designed. Since the depth of the reservoir depends on the distance c in Fig. 5(c), the depth of the reservoir 5 can be controlled accurately. Such a structure is very advantageous in view of assuring accuracy. Now, when the single-crystal Si substrate 102 is anisotropically etched using the alkaline liquid, the silicon oxide film 207 is also etched to reduce its thickness by about 0.4 μm. Thus, the silicon oxide film 207 has a pattern 0.1 μm at the area constituting the ink supply paths. The silicon oxide film 207 at the remaining areas has a thickness of about 0.6 μm.

As shown in Fig. 6(a), the substrate is immersed in a buffering hydrofluoric acid liquid for one minute to etch the silicon oxide film 207. Thus, the silicon oxide film 207 at the areas where the ink supply paths 8 and the reservoir 5 are to be formed is removed whereas the remaining silicon oxide film 207 is left with a thickness of about 0.5 μm.

As shown in Fig. 6(b), in order to form the areas 103 and 101 constituting the ink supply paths 8 and the reservoir 5, the substrate 102 is immersed in an alkaline liquid for its etching.

The process of the steps described above permits a plurality of units to be formed simultaneously in a Si wafer. This process, however, is excellent for achieving mass production and low cost.

As shown in Fig. 6(c), where the plurality of units, have been formed in the Si wafer, the units are separated from one another. Nozzle plates 12 of stainless or plastic each with a nozzle opening 10 are bonded together to complete an ink jet recording head.

Before the fabricating process is shifted from the step of Fig. 6(b) to Fig. 6(c), in this embodiment, the portions of the silicon oxide film 207 remaining on the non-active area and pressure generating chambers 4 have been removed. But, with the portions being left as they are, the nozzle plates 12 may be bonded together as shown in Fig. 6(c).

In the fabricating process described above, a potassium hydroxide (KOH) water solution having a concentration of 10% weight at 80°C was used for the first etching for the single-crystal Si substrate 102, another potassium (KOH) water solution having a concentration of 40% weight at 80°C was used for the second etching for the single-crystal Si; and a buffering hydrofluoric acid (HF) solution having 16% weight at room temperature was used for the silicon oxide film 207. In the condition described above, the etching rate of the single-crystal Si substrate 102 in the HF solution was 2.3 μm/min, and that of silicon oxide film 207 was 0.1 μm/min. In the first alkaline etching, the single-crystal Si was etched by 220 μm to form the deepest portion of each pressure generating chamber 4. Then, the ink supply paths 8, which are covered with the silicon oxide film 207, are not formed. The reservoir 5 is partially formed through the anisotropic etching. Further, the non-etched silicon oxide film 207 is subjected to photolithography. In the second alkaline etching (half-etching), the single-crystal Si was etched by 100 μm. Thus, in the step of Fig. 6(b), the ink supply paths 8 and reservoir 5 of the ink jet recording head were formed.

The above method precisely controls the groove depth of the reservoir 5. Further, even if the mechanical strength of the Si substrate is small, the reservoir does not become faulty from the vibration during the post fabricating step and transportation.

An explanation will be given of the ink jet recording apparatus using the ink jet recording head described above.

Fig. 8 is a perspective view of the ink jet recording apparatus incorporating the ink jet recording head according to the present invention. In Fig. 8, a recording head 301 is mounted on a carriage 304 secured to a timing belt 306 driven by a motor 305 and is designed to reciprocate in a width direction of a recording sheet of paper 307 transported by a platen 308 while being guided by a guide 309. The recording head 301 is supplied with ink necessary for jetting from an ink cartridge 302 containing an ink composition through an ink supply tube 303.

A capping device 310 serves to prevent clogging of the nozzle opening for discharging of ink drops when the recording head is in a non-printing state, and is connected to a sucking pump 311 to jet ink from the recording head 301, thereby relieving the clogging. A sucking pump 311 is connected to a waste ink tank 313 by a

tube 312.

The ink jet recording head according to the present invention can be applied to an ink jet recording apparatus with an ink cartridge mounted on the carriage, or with a recording head and an ink cartridge integrally formed.

To summarize, an object of the present invention is to provide an ink jet recording head which can compensate for shortage of mechanical strength of an ink reservoir 5 by preventing the piezoelectric film 3 on an ink reservoir from cracking or being broken due to the vibration of a piezoelectric film 3 or flowing or mechanical vibration of ink. The ink reservoir 5 has at least two plane orientations at its bottom and is given different depths.

Claims

1. An ink jet recording head comprising:

   a nozzle plate (12) having a plurality of nozzle openings (10) for discharging ink;

   a flow-path forming plate (1) including a plurality of pressure generating chambers (4) communicating with said nozzle openings (10), respectively, ink supply paths (8) for supplying ink to said pressure generating chamber (4) and a reservoir (5) communicating with said ink supply paths (8);

   a vibrating plate (2) formed on said flow-path forming plate (1);

   thin-film piezoelectric elements having electrodes (7) and piezoelectric films (3) formed at the areas on said vibrating plate (2) corresponding to said pressure generating chambers (4); and

   said reservoir (5) includes a common ink chamber (11) and a plurality of grooves (9).

2. An ink jet recording head according to claim 1, wherein said flow-path forming plate (1) is made of single-crystal silicon (Si).

3. An ink jet recording head according to claim 2, wherein said single-crystal Si plate (1) is in a (110) plane orientation and the one of each of the grooves (9) is in a (111) plane orientation.

4. An ink jet recording head according to any one of claims 1 to 3, wherein said grooves (9) are formed at the same pitch as that of said pressure generating chambers (4).

5. An ink jet recording head according to any one of claims 1 to 4, wherein said grooves (9) include walls (25, 26) formed therein, said walls (25, 26) are formed to have a lattice shape in said reservoir (5).

6. An ink jet recording head according to claim 1 or 5, wherein the plurality of grooves (9) are formed in a longitudinal direction of said pressure generating chambers (4), and the distance of the walls (25, 26) of said grooves (9) of said reservoir (5) extending in a direction of arrangement of said pressure generating chambers (4) is longer than that of those in a longitudinal direction of said pressure generating chambers (4).

7. An ink jet recording head according to any one of claims 1 to 6, wherein said common ink chamber (11) has a depth equal to that of said ink supply paths (8).

8. A method of fabricating an ink jet recording head, comprising the steps of:

   a first step of forming a single-crystal Si etch-resistant film (207) on a single-crystal Si substrate (201) having a (111) plane orientation;

   a second step of etching said single-crystal Si etch-resistant film (207) in a pattern of grooves having walls (25, 26);

   a third step of half-etching an area not etched in said second step;

   a fourth step of etching away the areas of said single-crystal Si substrate (201) which constitute a plurality of pressure generating chambers (4), a plurality of ink supply paths (8) and a reservoir (5);

   a fifth step of etching away said single-crystal Si etch-resistant film (207) half-etched in said third step; and

   a sixth step of etching the single-crystal Si exposed in said fifth step by a prescribed amount.

9. A method of fabricating an ink jet recording head according to claim 8, wherein said grooves (9) are formed at the same pitch as that of said pressure generating chambers (4).

10. A method of fabricating an ink jet recording head according to claim 8 or 9, wherein said walls (25, 26) of said grooves (9) are formed in a lattice shape in said reservoir (5).

11. A method of fabricating an ink jet recording head according to claim 8, wherein said grooves (9) are formed in a longitudinal direction of said pressure

generating chambers (4) and the distance of the walls (25, 26) of said grooves (9) of said reservoir (5) extending in a direction of arrangement of said pressure generating chambers (4) is longer than that of those in a longitudinal direction of said pressure generating chambers (4).

12. A method of fabricating an ink jet recording head according to claim 8, further comprising the step of forming a common ink chamber (11) having a depth equal to that of said ink supply paths (8).

13. An ink jet recording apparatus comprising an ink jet recording head and a timing belt wherein said ink jet recording head comprises:

a nozzle plate (12) having a plurality of nozzle openings (10) for discharging ink;

a flow-path forming plate (1) including a plurality of pressure generating chambers (4) communicating with said nozzle openings (10), respectively, ink supply paths (8) for supplying ink to said pressure generating chamber (4) and a reservoir (5) communicating with said ink supply paths (8);

a vibrating plate (2) formed on said flow-path forming plate (1);

thin-film piezoelectric elements having electrodes (7) and piezoelectric films (3) formed at the areas on said vibrating plate (2) corresponding to said pressure generating chambers (4);

said reservoir includes a common ink chamber (11) and a plurality of grooves (9); and

said grooves (9) include walls (25, 26) formed therein.

14. An ink jet recording apparatus comprising an ink jet recording head and a timing belt (306) according to claim 13 wherein said flow-path forming plate (1) is made of single-crystal silicon (Si).

15. An ink jet recording apparatus comprising an ink jet recording head and a timing belt (306) according to claim 14 wherein said single-crystal Si plate (1) is in a (110) plane orientation and the one of each of the grooves (9) is in a (111) plane orientation.

16. An ink jet recording apparatus comprising an ink jet recording head and a timing belt (306) according to claim 13 wherein said grooves (9) are formed at the same pitch as that of said pressure generating chambers (4).

17. An ink jet recording apparatus comprising an ink jet recording head and a timing belt (306) according to claim 13 wherein said walls (25, 26) of said grooves (9) are formed to have a lattice shape in said reservoir (5).

18. An ink jet recording apparatus comprising an ink jet recording head and timing belt (306) according to claim 13 wherein the plurality of grooves (9) are formed in a longitudinal direction of said pressure generating chambers (4), and the distance of the walls (25, 26) of said grooves (9) of said reservoir (5) extending in a direction of arrangement of said pressure generating chambers (4) is longer than that of those in a longitudinal direction of said pressure generating chambers (4).

19. An ink jet recording apparatus comprising an ink jet recording head and a timing belt (306) according to claim 13 wherein said common ink chamber (4) has a depth equal to that of said ink supply paths (8).

FIG. 1

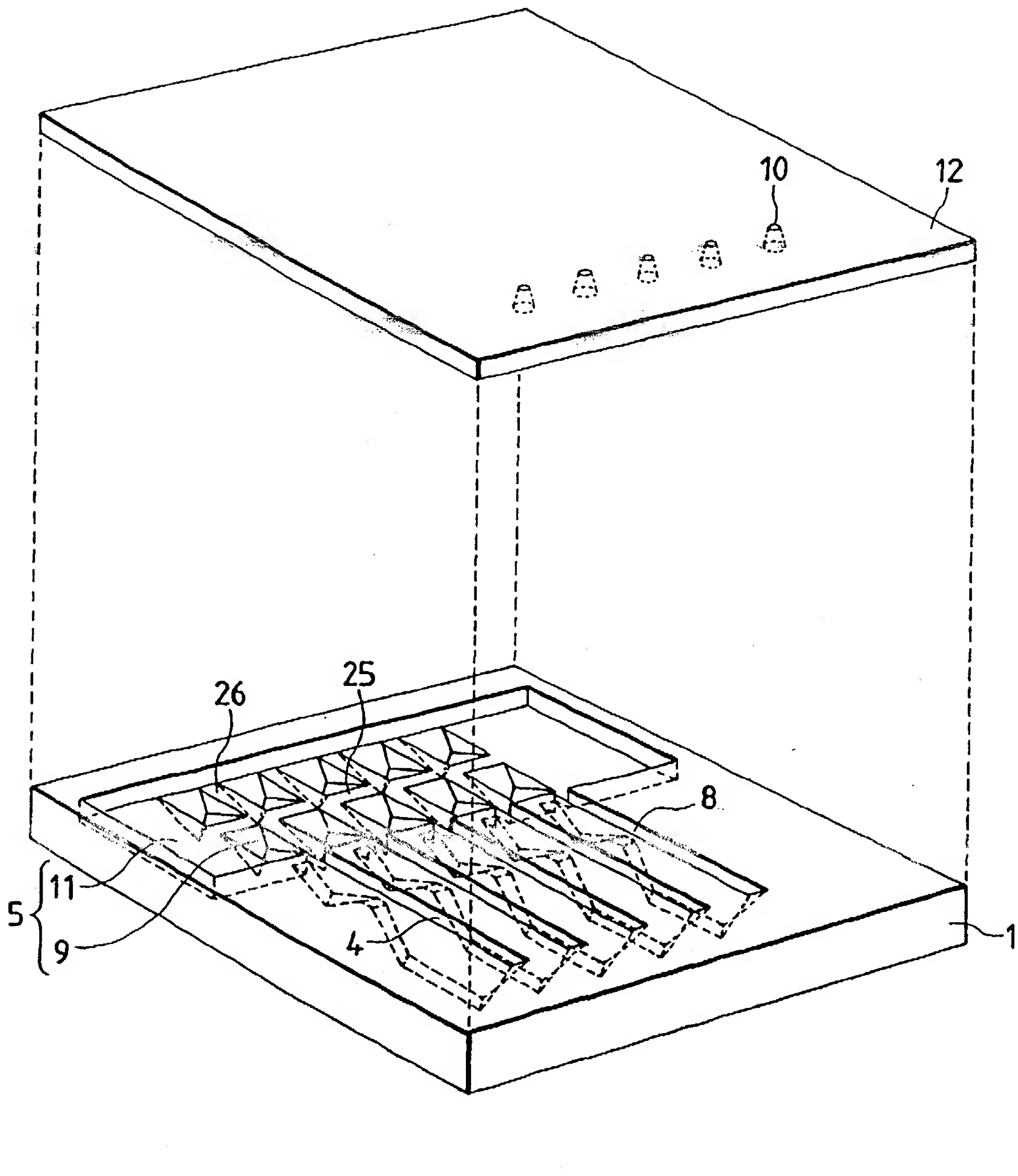
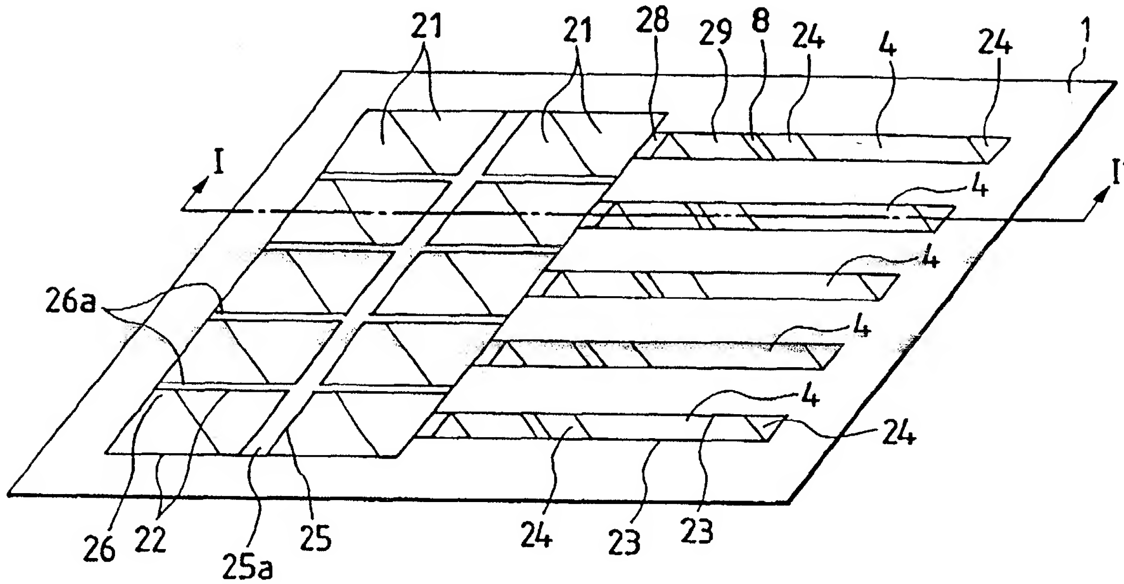


FIG. 2(a)


21
21
28
29
8
24
4
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I'
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4
26a
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25a
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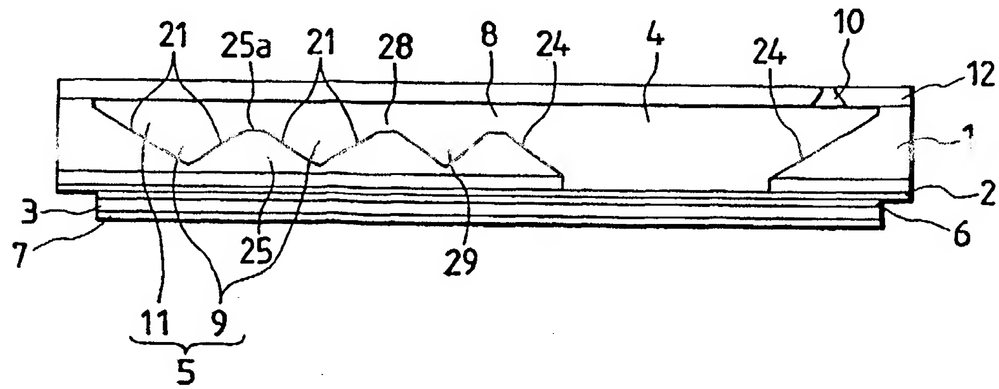
23

FIG. 2(b)


21
25a
21
28
8
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24
10
12
1
2
3
7
6
25
29
11
9
5

FIG. 3(a)

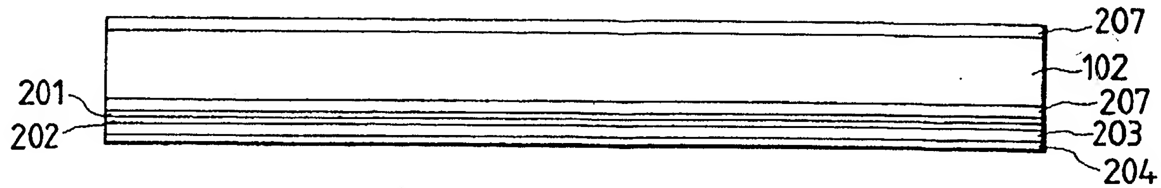

FIG. 3(b)

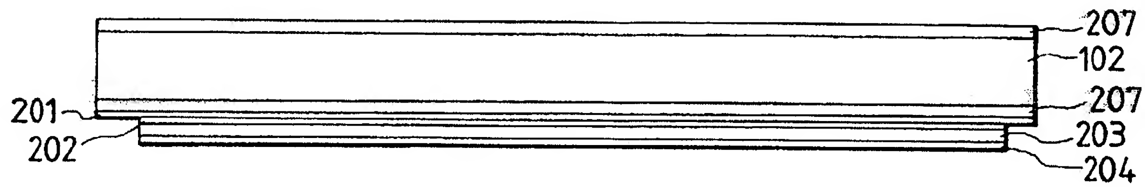

FIG. 3(c)

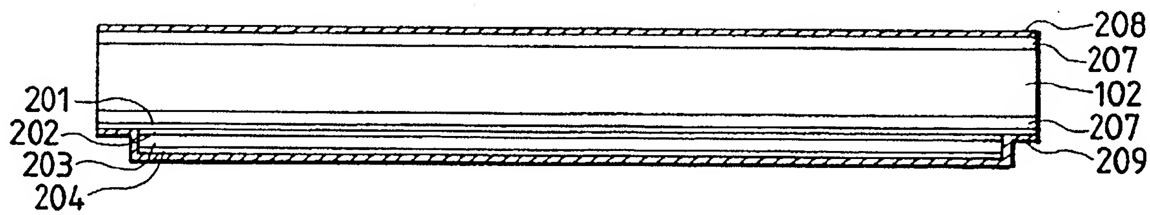

FIG. 3(d)

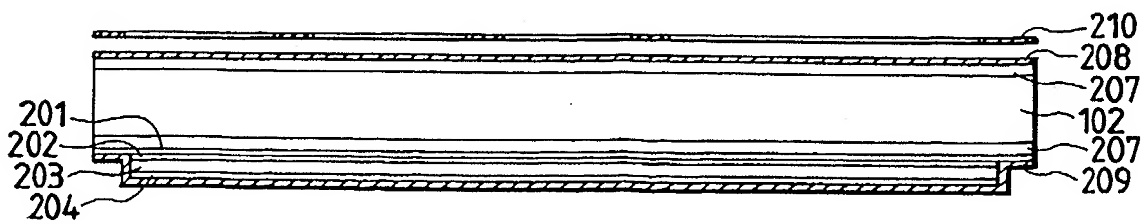

FIG. 4(a)

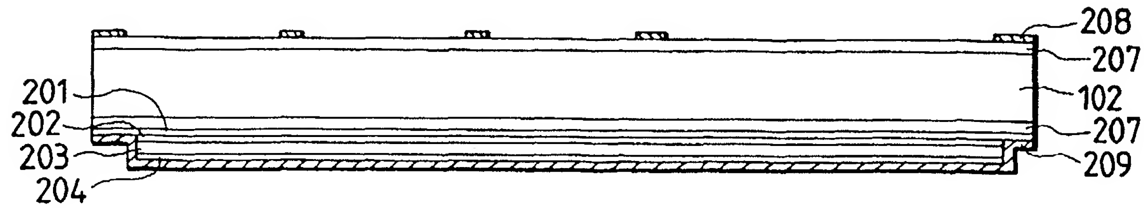

FIG. 4(b)

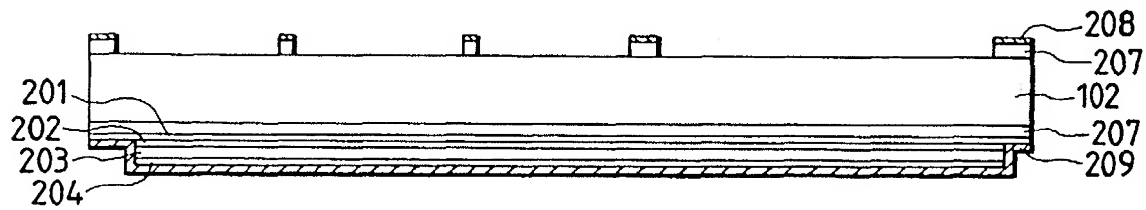

FIG. 4(c)

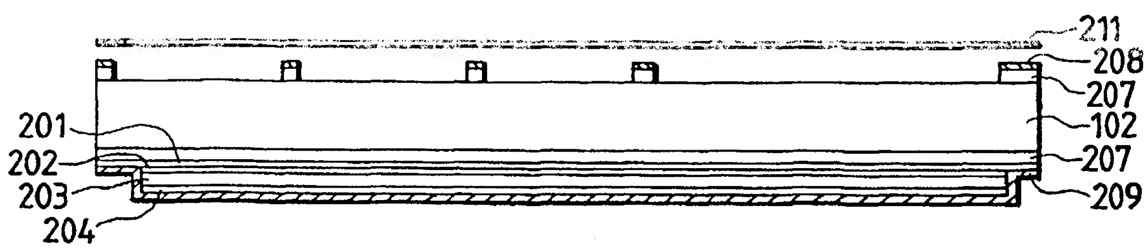

FIG. 5(a)

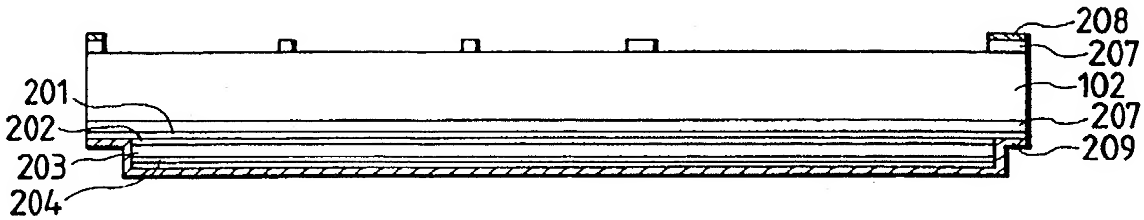

FIG. 5(b)

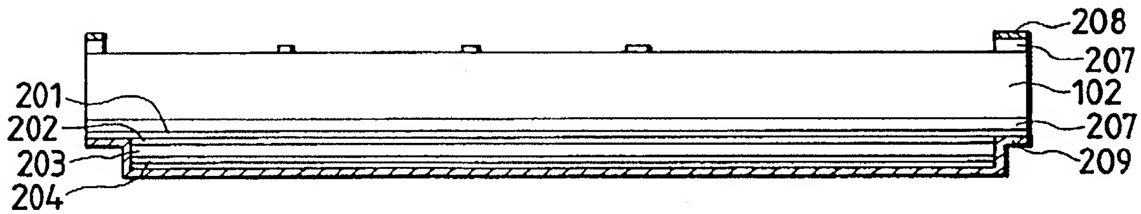

FIG. 5(c)

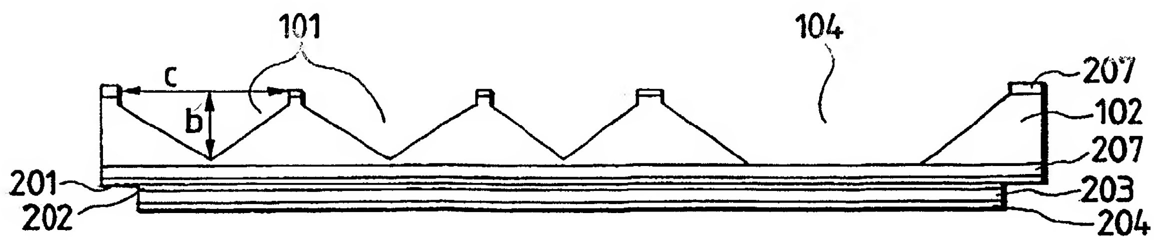

FIG. 6(a)

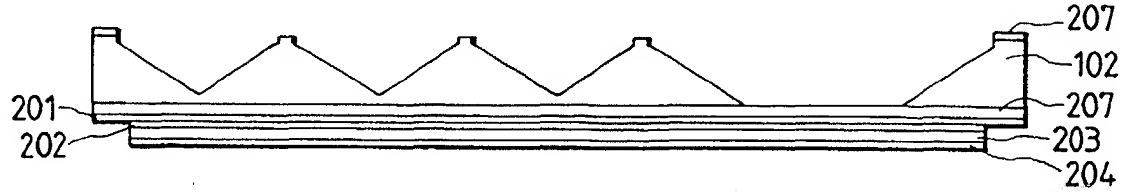

FIG. 6(b)

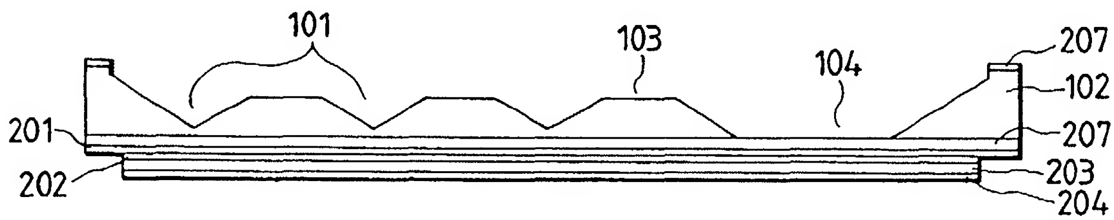

FIG. 6(c)

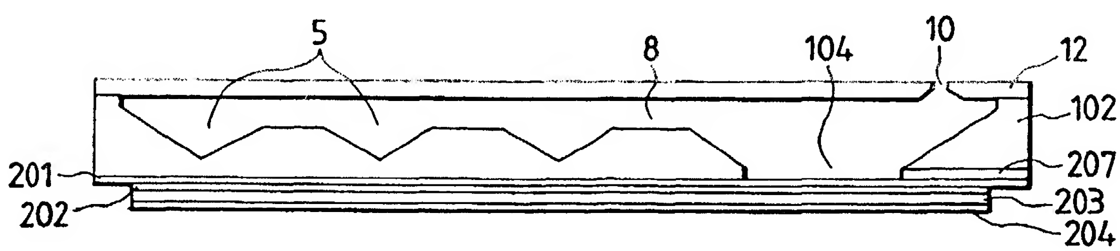

FIG. 7(a)

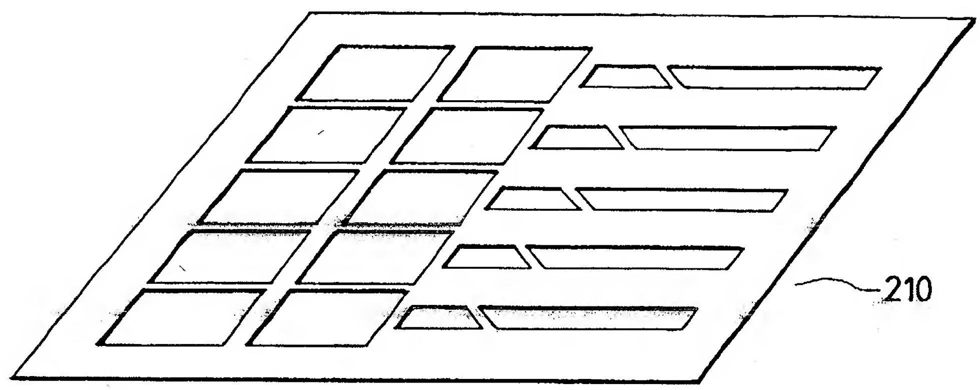

FIG. 7(b)

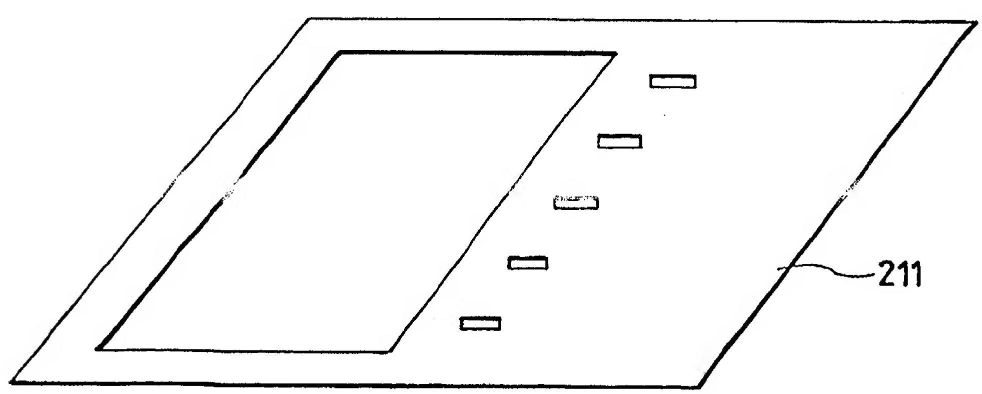

FIG. 8

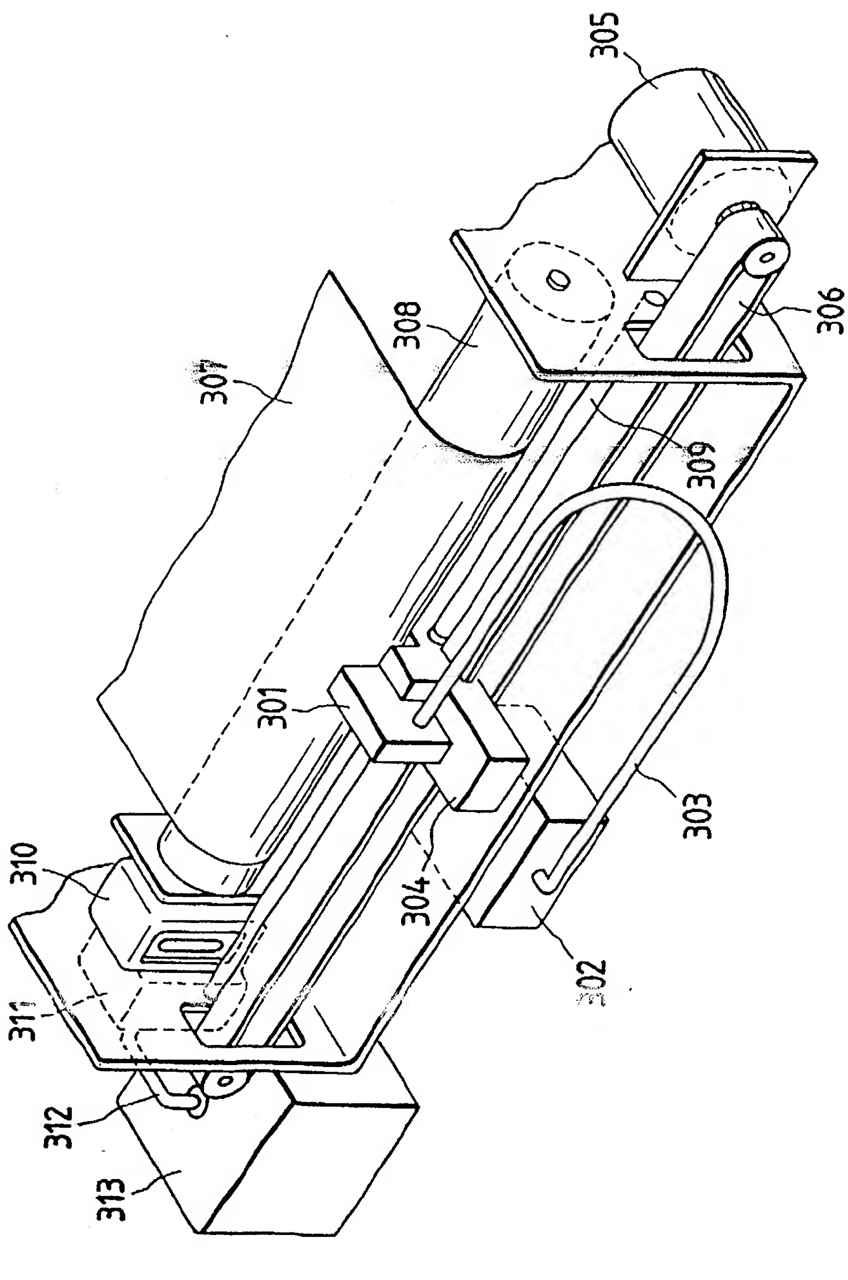

FIG. 9(a)

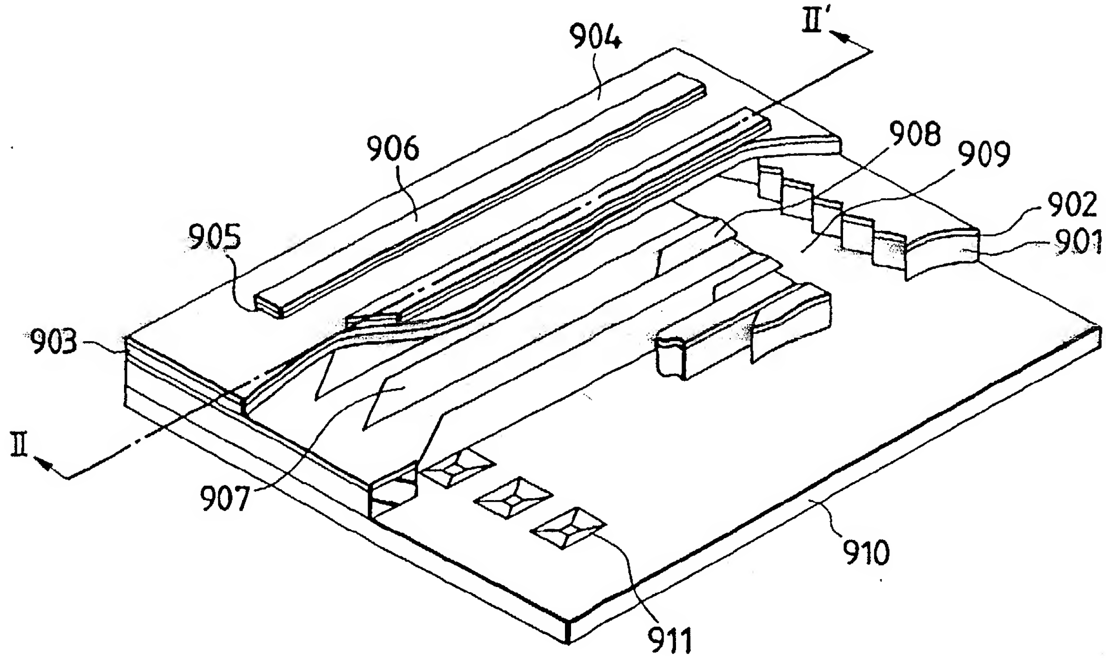
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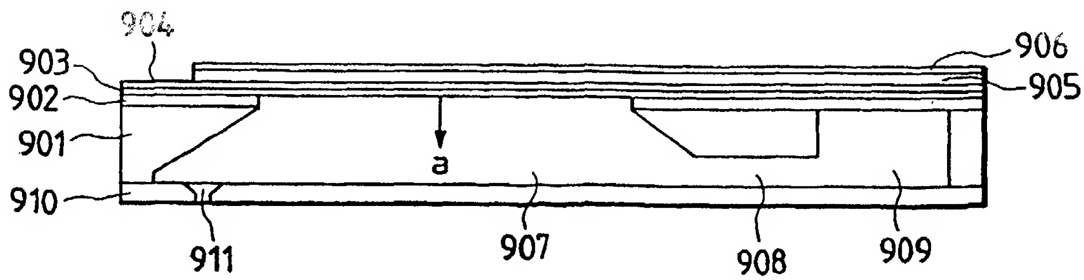
FIG. 9(b)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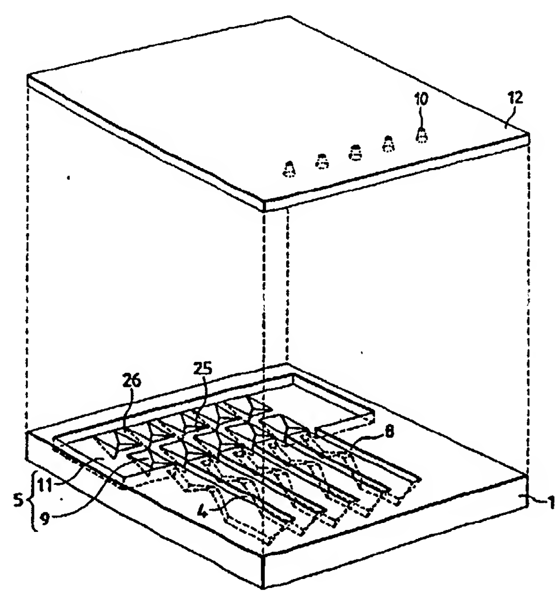
(54) Ink jet recording head, its fabricating method and ink jet recording apparatus

(57) An object of the present invention is to provide an ink jet recording head which can compensate for shortage of mechanical strength of an ink reservoir (5) by preventing the piezoelectric film (3) on an ink reservoir from cracking or being broken due to the vibration of a piezoelectric film (3) or flowing or mechanical vibration of ink. The ink reservoir (5) has at least two plane orientations at its bottom and is given different depths.

FIG. 1



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Application Number
EP 97 10 5692

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 18, no. 289 (M-1614), 2 June 1994 & JP 06 055733 A (SEIKO EPSON CORP), 1 March 1994 * abstract *	1,2,8, 13,14	B41J2/14 B41J2/16 B41J2/045
Y	PATENT ABSTRACTS OF JAPAN vol. 18, no. 526 (M-1683), 5 October 1994 & JP 06 183008 A (FUJI XEROX CO LTD), 5 July 1994 * abstract *	1,2,8, 13,14	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	3 November 1998	Ducreau, F

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 600 382 A (SEIKO EPSON CORPORATION) 8 June 1994 * column 4, line 20 - column 6, line 32; figures 1-3 *	1,2,8, 13,14	
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